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June 14, 1985

Steve Ostradka
U.S.EPA-Region V
Waste Management Div
5HR
530 S. Dearborn
Chicago, IL 60604

Dear Mr. Ostradka:

Enclosed is the final version of the soil sampling protocol, prepared by Ray Hinchman and Stan Zellmer of the soils lab here at Argonne. It has been revised to reflect comments we received.

The changes included: 1) reference to other industrial sources of lead near a source; 2) request to include distance from two roadways where a park or play area is adjacent to more than one busy street; 3) clarification of the reference to erosion deposition areas, which should be sampled only if they are in a play area; 4) clarification of the tools - non-painted tools or chromed are appropriate; 5) suggestion to use a tape measure across ditches or gullies to more accurately measure horizontal distance from a road; 6) additional description of the sample location, with respect to distance from any building less than 2 meters, because of the action of rain washing particulates off the walls into adjacent soils; 7) the obvious comment that loose soil should be replaced and sampled areas smoothed over so that no tripping hazard exists; and 8) revision of the sketch to show where both road distances are to be measured.

Some comments that were received resulted in no change in the text; response to them follows. One reviewer felt that all samples should be in the play area because the distance-from-the-road effect is well known. My research does not support that comment, because few studies have more than a dozen observations of road segments, and the range of average daily traffic (ADT) volumes studied is narrow, rarely over 50,000 ADT. We will have many locations near expressways of up to 200,000 ADT, and in areas where traffic density (ADT/sq mi) is very high or very low. We will be able to test the relationship to traffic density, not just traffic volume with our data, only if we have the distance samples.

The other major comment concerns the number of samples per site. We still request 4 per site, 2 distance-related from the surface, 1 surface in the play area, and 1 depth. If possible (depending on the park layout), the 100 ft (30.5 m) sample could be located in the play area, serving a triple purpose (the depth sample can be under the 100 ft. sample). However, we do ask for up to 8 samples per site as a precautionary measure. If some sites have data that appears inconsistent, such as the far soil sample having higher

lead than the close one, or two apparently similar sites with very different lead levels, extra samples taken now allow us to choose whether to analyze the additional samples. Since that would be a costly decision - lab time is not free - this will be weighed carefully should problems arise. Our basic analysis is still as agreed - 4 samples per site - but this method provides a

fallback that is relatively cheap if we do not use the samples ultimately, and high quality because the samples would all be taken at the same time, by the same person, using the same procedures.

We have scheduled a brief meeting on the protocol for those interested, who have been notified by phone, to answer questions of the field personnel. It will be held Monday, June 17, at 1:30, here at Argonne. (One EPA reviewer will call before that meeting with final comments.)

Sampling can begin now, as we are agreed on the procedure. It would be best for all sampling to take place in June, to allow the labs enough time to analyze the samples before September 1. If you will be much later than this, please let me know, to adjust expectations for our promised availability of results in the fall.

Enclosed is a copy of the labels Argonne will use for the sample bags. The pages of labels can be fed into a copying machine, to take the list from a typed original. A paper listing will be used for the labels to be put inside the sample bag with the soil. Thus, Argonne will send a paper copy and a self-stick label for each sample to the suburban sample collectors later this week, using the numbering system for sites and samples indicated in my June 5, 1985 memo. (A final list of suburban sites will be ready by June 14, and distributed next week.)

Have the rest of the downstate sites been named? Is the Chicago list correct as listed? Please let me know, at (312) 972-5629.

We are really moving along well!

Sincerely,

Sarah LaBelle

Sarah LaBelle

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SOIL SAMPLING PROTOCOL FOR THE DETERMINATION AND COMPARISON OF LEAD CONTENT IN PLAYGROUND SOILS

prepared by

Argonne National Laboratory
Energy and Environmental Systems Division
9700 South Cass Avenue
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SOIL SAMPLING PROTOCOL FOR THE DETERMINATION AND COMPARISON OF LEAD CONTENT IN PLAYGROUND SOILS

Introduction

The major goal of the playground soil study is to assess the potential health hazards to children of anthropogenic lead in the soils of play areas in public parks. To achieve this goal, the soil sampling and analysis effort must produce meaningful and comparable estimates of the lead concentration in diverse park soils in terms of stable numbers such as mean, range, and standard deviation with acceptable accuracy at the lowest possible cost. A good sample is the first criterion for a reliable soil test. A good sample is one member of a set of samples, all of which have been collected and handled in a consistent and uniform manner prior to delivery to the laboratory. Considerable care and standardized methods must be used in the collection of all soil samples, because this is the largest source of variability and error.

The objective of this soil sampling protocol is to provide such a standardized procedure that is rapid, simple, and adaptable to most situations that will be encountered in the field.

Rationale and Assumptions

This soil sampling protocol is based on the assumption that the anthropogenic lead in the surface soils of parks comes primarily from the large particulates in the exhaust of vehicles burning leaded gasoline that travel on nearby roads and streets (Lagerwerff and Specht, 1970). If this is the case, lead concentration in park soils should decrease as distance from the roadway increases, assuming fairly rapid settling and deposition from the atmosphere onto the soil surface. Lead particulates deposited on other surfaces (plants, structures, etc.) are eventually washed off by precipitation and are deposited on the nearby soil surface as well. Thus, the presence of trees, shrubs, and structures are an important consideration as well.

The presence of peeling point on nearby buildings or on the playground equipment is also important, as is location near an industrial source of airborne lead. Although anthropogenic lead is likely to be mainly from automobile exhaust, in a few cases these other sources may influence soil lead and should be noted.

The relative concentration of lead (when compared between sites) at a given distance from a road is assumed to be governed by variable factors such as traffic density on the road, direction of the prevailing wind, and soil type. Because lead is relatively immobile in soil (MacLean et al, 1969), most of the anthropogenic lead is assumed to be in the surface soil (upper 2" or 5 cm).

To quantify this soil lead concentration gradient around roadways, three standard samples will be taken at each site (park or playground). Two of these will be surface samples at the prescribed distances of 10 feet (3 m) and 100 feet (30.5 m) from the nearest road. These samples can be

accommodated at most sites and will permit between-site comparisons with the variables reduced to a minimum. The third standard sample will be taken at 10"-12" (25-30 cm) below the surface and will be taken at the same sample location as the surface sample that is farthest from the road. This sample will be used to determine the background or natural level of lead in the soil (i.e., prior to anthropogenic additions). At least two additional surface samples of play areas and/or adjacent vegetated areas should be taken at each park.

Vegetated as well as bare areas should be sampled. Bare areas are and have been much more susceptible to erosion by wind and water than vegetated areas, especially with the added disturbance factor in play areas of many shuffling feet. Because of this, the surface layer (which often contains the most lead) may be gone. This is often exemplified by the "dished-out" appearance of the bare areas under or around playground equipment. In addition, new playground equipment may be installed or existing equipment moved, which would result in the development of new bare areas on surfaces that are currently vegetated. Vegetated areas (grass, shrubs, trees, etc.), because of the additional surface area of the plant surfaces, also probably "catch" or filter out more airborne particulates (including lead) than bare areas of similar size. Much of this surface-deposited lead on vegetation is washed onto the soil in the immediate vicinity of the plants by precipitation. Because of these considerations, it would be useful to know the lead content of the less-eroded surface soil comprising the vegetated areas of parks. Samples from vegetated areas need to be clearly identified as such.

One or two parks in each major sampling area (Chicago, suburbs, and the rest of the state) will be more intensively sampled to obtain an estimate of sampling error by taking three individual and separately bagged soil samples at each sample location. These replicate samples should all be taken within an area of several square feet and include both surface and the 10"-12" samples. The three 10"-12" samples can be obtained from the same hole. These sites will be designated in advance, and the soil sample collector will be notified. Special instructions for labeling those samples will be included in the packet for these sites.

Soil Sampling

Site Reconnaissance. The first step in the soil sampling procedure is to do a quick reconnaissance of the site by walking around the perimeter (or part of it) with the park diagram (that has been supplied) in hand. Mark the locations of playground equipment and other major structures on the diagram. Confirm the directional indicator and locations of streets, roadways, or other landmarks shown on the diagram (Fig. 1). Since park size, shape, and placement of playground equipment and recreational areas can vary widely, it is not possible to prescribe a definite predetermined sampling pattern, although a straight-line transect (described below) can be used at most sites. Use good judgment in identifying obvious play areas used by young children (e.g., swing sets and slides rather than a baseball diamond) for the play area samples.

Sample Location Selection and Measurement. Using your completed park diagram (Fig. 1), you will be selecting a minimum of five sample locations. Two of these will be the surface samples at the predetermined distances of 10

ft. (3 m) and 100 ft. (30.5 m) from the edge of a roadway and a third will be the 10"-12" background (natural) lead level sample which will be taken at the same location as the surface sample most distant from the roadway. For the current study, this location should probably be within 1000 ft (305 m) of the roadway. For the play area sample, select a location different from the standard samples. If there are several play areas, please collect as many other surface samples in them as time permits. For every sample location, the distance to the nearest roadway must be measured. In parks or playgrounds near two busy arterial streets or freeways, note the distance from the two roadways to the starting point of the sampling transect, i.e., locate the transect, as well as distances along the transect.

Measurement by pacing the distance is acceptable. However, each soil sample collector should calibrate his or her stride by counting the number of normal paces in a known distance and dividing the total distance by the number of paces. This should be done several times and the average pace length used for measuring distances.

If possible, for ease in measurement and to save time, the sample locations should be selected such that they can be lined up along an imaginary straight line or transect. In this way, all of the sample location distances can be measured (by pacing) and sampled by walking the transect once and back again. For measurement and sampling purposes, the transect can be considered a "belt" up to 10 feet wide, to permit inclusion of nearby potential sampling locations (see Fig. 1). In those areas where deep roadside ditches or other steep-sided depressions that cannot be stepped across are intersected the transect, span these areas with a measuring tape rather than pacing (which could result in discrepancies in linear distance) and pick up pacing beyond them. Select level areas for sample locations to avoid areas that may have lost surface soil by erosion. Also, do not select a sample location at the base of a slope or an area that is obviously an erosion deposition area unless this is also a play area. Try not to sample on dry, windy days when dust is blowing. Also, be sure to wipe the sampling tools clean after each sampling to avoid contamination.

Because isopleths of lead concentration in the surface soil are probably roughly parallel to roadways, the sampling transect should be somewhere between perpendicular and a 45° angle with a boundary roadway. If a sampling transect can be set up so that the 100 foot standard sample falls within a play or other recreational use area, all the better; but identify a sampling location at 10 feet and 100 feet from the roadway for each site, regardless of where these sample locations occur. Whether the samples are collected along a transect or from scattered locations, be sure that all sample locations are clearly indicated on the site diagram and that all of the information requested on the soil sample data sheet (Fig. 2) is provided for each sample.

Plan to take as many samples over the minimum of four at each site as time permits (up to eight samples). Even though all the samples from each site may not be used in the first round of analysis, if the initial results reveal interesting trends or "hot spots", the additional samples will be on hand that could be worked up quickly to supplement the initial data. The additional cost of taking several extra samples is small compared to the cost of getting the sample collector to the site.

Soil Sampling Equipment. The following equipment will be needed by each soil sampler to collect and preserve soil samples using this protocol:

1. Plastic zip-loc bags, 4" x 6".

2. Pre-printed self-stick soil bag label and bag tag combination. The bag tags (inserted inside the bag with the soil sample) are identical to the label and will be printed on bond paper, cut to size.

3. Soil sampler (bulb planter). 2 1/4" diameter at base, slightly tapered toward larger opening at top with marking (or scratch) on inside 2" above edge of base. Model BP, 9 1/2" long "Pacemaker" brand. Available from garden stores or: A.H. Hummert Seed Company, 2746 Chouteau Ave., St. Louis, MO 63103, (800) 325-3055.

BULB PLANTERS
Durable chrome plated, for rustproof protection.

Model No. BP - 9¾" Long

4. Trowel (chrome or unpainted surface). To dig soil away from side of soil sampler to permit insertion of scraper.

5. Flat-blade scraper (chrome or unpainted surface), 3" wide with straight edge. To cut off soil core at base of sampler and to keep soil from falling out of sampler. Available from hardware store.

6. Garden or tiling spade. To dig 8" deep, flat bottomed hole for obtaining the 10"-12" sample for background lead level. Available from hardware store.

7. Scissors or shears (chrome). To clip vegetation from sampling area. Available from hardware store.

8. Cloths or towels. To wipe off sampling tools between samples to avoid contamination.

Collecting the Soil Samples.

- At each site (park), start sampling with the least contaminated sample location (farthest from roads) and work toward the road so contamination from higher lead areas is not carried over to less.
  - To do this, start at the roadway end of your sampling transect and as you walk toward the most distant sample location, note the distance (by pacing) of each sample location on the site diagram (Fig. 1) and on a soil sample data sheet (Fig. 2) as you pass the sample locations.

- When you reach the far sample location, you will take a surface sample and a 10"-12" sample at the same place.

o Before taking any soil sample, complete the preprinted label combination (self-stick label for soil bag and backing paper label to go inside bag). Record the date and the sampler's initials. Apply the label to the outside of the bag.

o Complete the soil sample data sheet (Fig. 2) by recording date, site (park) name, sample number, distance to roadway, ground surface condition, presence of other lead sources, site use, and sampler's initials. Any special conditions or circumstances should be noted in the comments section including presence of structures or buildings within two meters of the sample.

o Many of the surface samples will be taken from bare ground areas around or under playground equipment. For these areas, push the sampler into the soil with a twisting motion until the soil surface inside the sampler is even with the marks or scratch (2" above bottom edge).

- With the sampler held in place, use the trowel to dig or scrape the soil away from one side of the sampler until the bottom edge is exposed.

- Push the scraper blade straight across the bottom of the sampler to cut off and free the soil core inside the sampler.

- With the scraper held in place under the sampler, lift straight up and deposit the soil sample in the bag.

- Insert the duplicate label tag and seal the bag securely.

- Smooth over the area where the sample was taken, so that surface is even.

o **General note:** Soil samples will hold together better and are easier to take if the soil is slightly moist (not wet) when the samples are taken. Dry, compacted soils (e.g., play areas) can be very difficult to push the sampler into.

o After sampling, brush or wipe off any adhering soil on the sampling tools and prepare to take the next sample.

o For the 10" to 12" background lead level sample, dig a flat-bottomed hole 8 in. (20 cm) deep with the spade. The hole must be wide enough to use the trowel to expose the bottom of the sampler and to insert the scraper.

- From the bottom of this hole, take a 2" soil core with the sampler as for a surface sample.

- Discard this sample.

- Take another 2" soil core from the same core-hole as the first, being careful not to contaminate the core-hole or the sample with surface dust or soil.

- Replace the loose soil in the hole so that the surface is reasonably level.

o At each site (park), take at least one sample from a vegetated area adjacent to (same distance from road) a bare ground (play area) sample to compare lead levels in bare vs. vegetated soil.

o When sampling the vegetated area, cut the vegetation with the scissors as close to the soil surface as possible from an area large enough to take the soil sample and discard the clippings. Do not pull up the vegetation or otherwise disturb the soil surface.

- Proceed with the sampling procedure as described for bare soil.

- Be sure the soil surface is aligned with the 2" mark in the sampler.

- The plant parts remaining in the soil will be removed from the sample in the lab during preparation for analysis.

Surfaces Other Than Soil or Vegetation

o If a play area is covered with loose gravel, shredded wood, bark chips, or other mulch material, carefully remove the gravel or mulch to expose the soil surface of an area large enough to take the sample. Take the soil sample the same as for a bare area.

o Do not sample sandboxes or play areas covered with sand. Rather, sample a bare or vegetated soil area adjacent to sand-covered areas.

o After collection, the samples should be delivered to the lab or to the intermediate collection point for analysis as soon as possible along with copies of all sample data sheets and site diagrams.

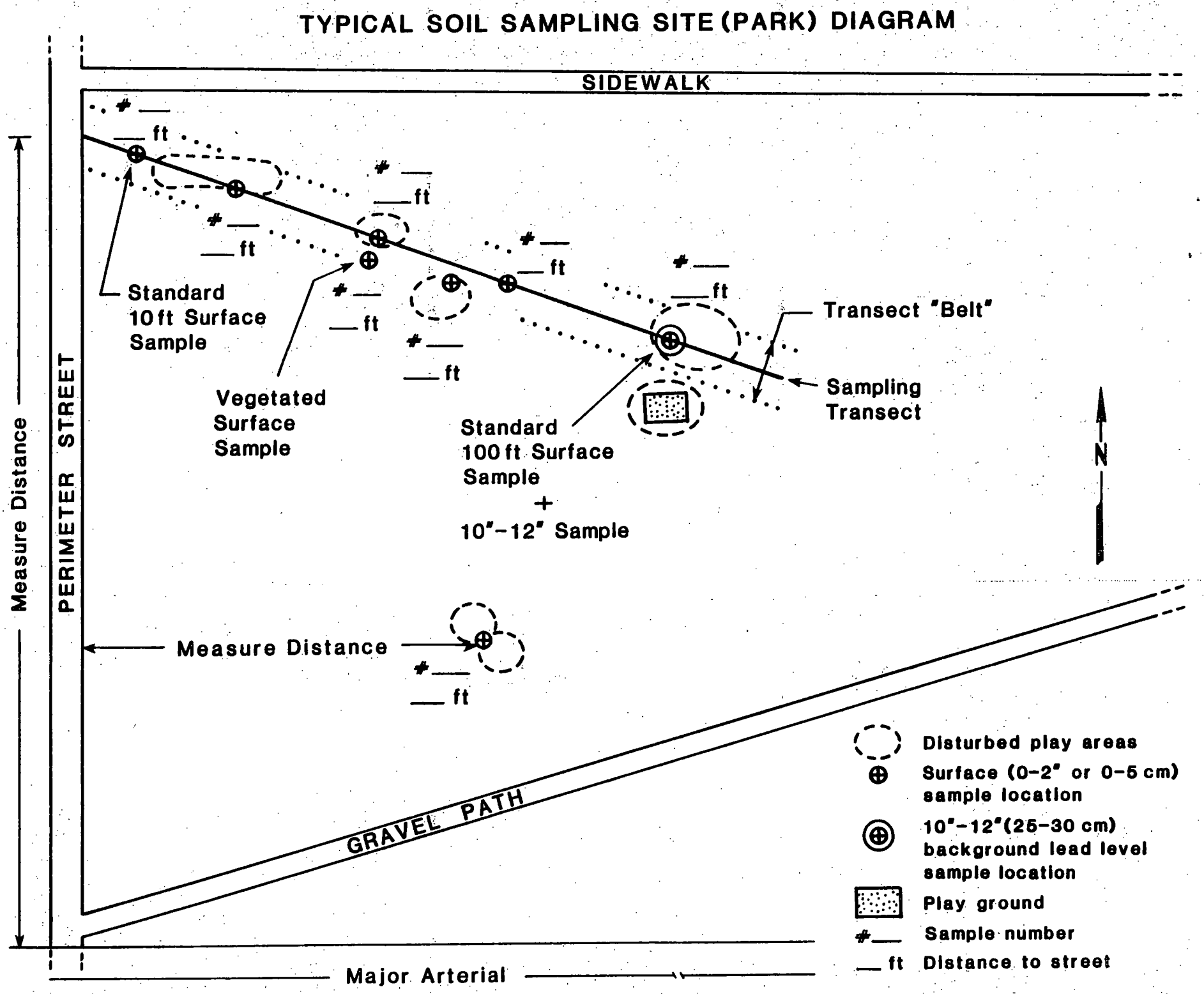
Sampling Uniformity.

o To ensure sampling uniformity, all samples collectors should be supplied with identical sampling equipment. A practice session should be conducted for the soil sampling team (as a group) at which methods are demonstrated and each member conducts all sampling procedures under field conditions. In this way, any questions and/or uncertainties can be resolved before actual sampling begins.

References

Lagerwerff, J.V., and A.W. Specht, 1970, **Contamination of Roadside Soils and Vegetation with Cadmium, Nickel, Lead and Zinc**, Environ. Science and Tech. 4(7):583-586.

MacLean, A.J., R.L. Halstead, and B.J. Finn, 1969. **Extractability of Added Lead in Soils and its Concentration in Plants**, Can. J. Soil Sci. 49:327-334.


TYPICAL SOIL SAMPLING SITE (PARK) DIAGRAM
SIDEWALK
Number
Name of Park
Measure Distance
PERIMETER STREET
___
___ ft
Standard
10 ft Surface
Sample
Vegetated
Surface
Sample
Standard
100 ft Surface
Sample
+
10"-12" Sample
Transect "Belt"
Sampling
Transect
N
Measure Distance
GRAVEL PATH
Major Arterial
Disturbed play areas
Surface (0-2" or 0-5 cm)
sample location
10"-12" (25-30 cm)
background lead level
sample location
Play ground
#___ Sample number
___ ft Distance to street

LEAD IN PARK SOILS
Soil Sample Data Sheet

Sample No._____ Date_____

Location _____ Collected by_____

☐ standard 10 ft (3 m) surface sample. Distance to transect from parallel busy road_____

☐ standard 100 ft (30.5 m) surface sample.

☐ standard 10"-12" depth sample. Distance to nearest road _____

☐ play area sample. Distance to nearest road _____

☐ other surface sample Distance to nearest road_____

Ground surface (check all that apply)

☐ disturbed

☐ under/around playground equipment. Kind _____

☐ other _____

☐ gravel or mulch. Kind: _____

☐ bare (undisturbed - no vegetation)

☐ vegetated

☐ grass

☐ other _____

☐ under tree (within dripline)

☐ near a building - within 2 m (6.5 ft) (note below if lead-pained exterior surface)

Presence of other possible sources of lead contamination (i.e., painted surfaces) within 10 feet (3 m)

☐ No

☐ Yes - Describe _____

Site Use

☐ Public recreational area

☐ Other_____

Comments